PATENT SPECIFICATION

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Complete Specification Left: March 4, 1942.

Complete Specification Accepted: June 3, 1942.

PROVISIONAL SPECIFICATION

Improvements in and relating to Apparatus applicable to Screw Propellors for obtaining Maximum Efficiency under all conditions

We, MICHAEL THADDIUS ADAMTCHIK, of "Maroc," Chichester Drive, Saltdean, Sussex, a Lithuanian subject, and JAMES RUSSELL KENNEDY, of 14, Royal Avenue, Chelsea, London, S.W.3, a British subject, do hereby declare the nature of this invention to be as follows:—

This invention relates to an apparatus applicable to aerial and marine screw propellers and has for its object an apparatus which when used in conjunction with a screw propeller enables the latter to operate at its maximum efficiency throughout its entire range of operation.

In order to achieve this result various arrangements have been used hitherto. One arrangement, generally known as a variable pitch propeller, is based on changing the ratio of the mean geometrical pitch of the propeller relatively to its diameter. This arrangement, however, has the disadvantage that it is complicated, by reason of the necessity of pivoting the blades under a load produced by the centrifugal force acting on the blades, an excessive effort is required to pivot the blades, and the efficiency is low when the ratio of the geometrical pitch to the diameter of the blade is small.

Another known method is to provide the screw propeller with fixed or adjustable vanes for imparting to the ingoing fluid a counter swirl substantially in excess to the circumferential drag of the impeller. Under these conditions the coefficient of the load of a given propeller increases by reason of the increase of the rotational momentum. However the conditions only obtain at the commencement of the propeller operation and no provision is made for obtaining suitable conditions at cruising or maximum speeds.

In a third known arrangement adjustable inlet guide vanes of symmetrical aerofoil section are provided so as to produce a positive or negative swirl in the ingoing fluid so as to decrease or increase the rotational momentum of the screw propeller. This arrangement has two serious disadvantages namely, due to the symmetrical outline of the vanes these have excessive angles of attack on the ingoing fluid when large angles of deviation are used, whilst symmetrical inlet guide vanes deviate the incoming fluid equally along the blades irrespective of the vastly different circumferential moments produced by the various parts of the blades.

The real purpose of inlet guide vanes in an aerodynamic sense is to produce an alteration in the "circulation" of the fluid around the propeller blades, the "circulation" being the expression $\int V \cos \theta ds$, where V = the velocity around an aerofoil; θ = the angle between the path around the aerofoil and the path of movement of the air, and ds = an element of the path.

It is known that the blades of a screw propeller may be designed either for a constant "circulation" or for a variable "circulation."

Investigations have shown that adjustable or fixed inlet guide vanes at present in use are not capable of producing variations in the "circulation" which are comparable with those produced by variable pitch propellers, as only a small increase in the "circulation" is obtained by the use of negative angles of pivoting of about 10° to 15°, the "circulation" decreasing when the angle of pivoting is increased beyond these values. This is due to the use of symmetrical aerofoils which produce a variation of the "circulation" which is not directly proportional to the "circulation" along the bladt.

It has now been found that in order to obtain the maximum efficiency at every position of the inlet guide vanes it is necessary to produce an increment in the "circulation," either negative or positive, which is proportional to the basic variations in the "circulation" along the blade. This implies the use of stationary inlet guide vanes having a variable pitch and a variable camber of aerofoil section.

The present invention obviates the disadvantages of the known arrangements referred to above.

According to the present invention a number of flexible preferably hollow vanes of variable pitch and variable camber are arranged to be pivotally mounted in a stationary position, relatively to a screw propeller, so as to enable them to be set at a positive or negative angle and of which the curvature is variable to a maximum amount of ± 20% from the neutral position. The vanes may be constructed of stainless sheet steel of high elasticity or of other suitable material, for example canvas. The vanes are preferably constructed in sections arranged in close fitting overlapping relationship along the length of the vane so as to assume the various required positions.

Preferably the number of vanes is greater by one than the number of propeller blades so as to avoid sound interference between the blades and vanes. The vanes are preferably mounted between a central hub and an outer casing member so as to form a self-contained unit applicable to any type of engine in a stationary manner. Means are also provided for varying the position of the vanes simultaneously.

In carrying the invention into effect according to one example of construction as applied to an aircraft engine, the apparatus consists of a central streamlined boss which is shaped to correspond with the adjacent aircraft or engine frame to which it is to be attached. Arranged in spaced relation to the boss is a circular outer casing member of streamline shape which may extend over the propeller blades with slight clearance. The outer casing member is preferably of material sold under the Registered Trade Mark "Duralumin" and in cross section resembles a hollow aerofoil of which the outer side is formed of sheeting.

In the hub and casing there are mounted uniformly spaced shafts on which sleeves are rotatably mounted. On each of these sleeves is mounted at its leading edge a hollow vane of aerofoil cross section. These vanes are of stainless sheet steel of high elasticity or other strong material. Preferably each vane consists of a number of sections arranged side by side along the length of the vane and slightly overlapping one another.

Intermediate the leading and trailing edges of each vane, preferably nearer to the trailing edge, a second shaft passes through the vane parallel to the first shaft.

Around the boss there is mounted concentrically a casing member which is secured positively to the boss. The shafts and sleeve pass through this casing member whilst the first shaft is secured to the boss. To the lower end of the sleeve, inside the space between the casing member and the boss, there is secured a lever having a short slot for the reception of the lower end of the second shaft. Between the two shafts the lever carries a guide pin, whilst a guide pin is also secured to the lower end of the second shaft. A sleeve is also mounted rotatably around the second shaft and to the lower end of this sleeve there is secured a guide pin. The guide pins engage with slots in a governor plate. The guide pin on the lever engages with the first slot, the guide pin on the second shaft with the second-slot and the guide pin on the sleeve on the second shaft engages with the third slot.

The first and third slots are parallel to one another and extend at about an angle of 45° across the central plane of the vane, the third slot being shorter than the first.

The second slot is longer than the first slot and from its centre extends forwardly.

By moving the governor plate forwardly or rearwardly the curvature and the geometrical pitch of the vanes can be varied as may be desired so as to vary the "circulation."

The governor plate can be moved manually, hydraulically, mechanically, pneumatically, electrically or in any other suitable manner.

As will be appreciated a separate governor plate is provided for each vane, the separate plates being coupled together in any suitable manner so as to operate in synchronism.

The plate is preferably brought into the neutral position for a cruising speed which determines the most suitable ratio of the geometrical pitch to the diameter of the propeller for the design of the latter.

For taking off there are used the negative angles of pivoting and for maximum speed the positive angles of pivoting.

When the governor plate is in the neutral position the guide pins are all in alignment with the central plane of the vane.

When all the slots are parallel to another then on movement of the governor plate the vane has a constant angle of inclination. By constructing the central slot as above described a variable angle of inclination is obtained, the angle being greater at the tip than at the hub end of the vane. Further by the engagement of the third guide pin with its slot there is also effected a twisting of the vane into an aerofoil of different curvature.

By making the hub hollow the apparatus can be arranged in front of a hollow propeller hub without interfering with fixing through the propeller hub.

As the hub is stationary the application

of de-icing arrangements is facilitated.

Provision may also be made for circulating heated air through the shafts and shroud for preventing the formation of ice.

Dated this 4th day of February, 1941.

For the Applicants,
A. P. THURSTON & CO.,
329, High Holborn, London, W.C.1.
Chartered Patent Agents.

COMPLETE SPECIFICATION

Improvements in and relating to Apparatus applicable to Screw Propellors for obtaining Maximum Efficiency under all conditions

We, MICHAEL THADDIUS ADAMTCHIK, of "Marce," Chichester Drive, Saltdean, Sussex, a Lithuanian subject, and JAMES RUSSELL KENNEDY, of 14, Royal Avenue, Chelsea, London, S.W.3, a British subject, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to an apparatus applicable to aerial and marine screw propellers and has for its object an apparatus which when used in conjunction with a screw propeller enables the latter to operate at its maximum efficiency throughout its entire range of operation.

In order to achieve this result various arrangements have been used hitherto. One arrangement, generally known as a variable pitch propeller, is based on changing the ratio of the mean geometrical pitch of the propeller relatively to its diameter. This arrangement, however, has the disadvantage that it is complicated, by reason of the necessity of pivoting the blades under a load produced by the centrifugal force acting on the blades, an excessive effort is required to pivot the blades, and the efficiency is low when the ratio of the geometrical pitch to the diameter of the blade is small.

Another known method is to provide the screw propeller with fixed or adjustable vanes for imparting to the ingoing fluid a counter swirl substantially in excess to the circumferential drag of the impeller. Under these conditions the coefficient of the load of a given propeller increases by reason of the increase of the rotational momentum. However the conditions only obtain at the commencement of the propeller operation and no provision is made for obtaining suitable conditions at cruising or maximum speeds.

In the third known arrangement adjustable inlet guide vanes of symmetrical aerofoil section are provided so as to produce a positive or negative swirl in the ingoing fluid so as to decrease or increase the rotational momentum of the screw propeller. This arrangement has two serious disadvantages namely, due to the symmetrical outline of the vanes these have excessive angles of attack on the ingoing fluid when large angles of deviation are used, whilst symmetrical inlet guide vanes deviate the incoming fluid equally along the blades irrespective of the vastly different circumferential moments produced by the various parts of the blades.

The real purpose of inlet guide vanes in an aerodynamic sense is to produce an alteration in the "circulation" of the fluid around the propeller blades, the "circulation" being the expression $\int V \cos \theta ds$, where V = the velocity around an aerofoil; θ = the angle between the path around the aerofoil and the path of movement of the air, and ds = an element of the path.

It is known that the blades of a screw propeller may be designed either for a constant "circulation" or for a variable "circulation."

Investigations have shown that adjustable or fixed inlet guide vanes at present in use are not capable of producing variations in the "circulation" which are comparable with those produced by variable pitch propellers, as only a small increase in the "circulation" is obtained by the use of negative angles of pivoting of about 10° to 15°, the "circulation" decreasing when the angle of pivoting is increased beyond these values. This is due to the use of symmetrical aerofoils which produce a variation of the "circulation" which is not directly proportional to the "circulation" along the blade.

It has now been found that in order to obtain the maximum efficiency at every position of the inlet guide vanes it is necessary to produce an increment in the "circulation," either negative or positive, which is proportional to the basic variation in the "circulation" along the blade. This implies the use of stationary inlet guide vanes having a variable pitch and a variable camber of aerofoil section.

The present invention obviates the disadvantages of the known arrangements referred to above.

According to the present invention a number of flexible preferably hollow vanes of variable pitch and variable camber are arranged to be pivotally mounted in a stationary position, relatively to a screw propeller, so as to enable them to be set at a positive or negative angle. The setting angle is preferably variable to a maximum amount of ±20% from the neutral position for high efficiency. When efficiency is not of primary importance the angle of curvature may be greater. The vanes may be constructed of stainless sheet steel of high elasticity or of other suitable material, for example canvas. The vanes are preferably constructed in sections arranged in close fitting overlapping relationship along the length of the vane so as to assume the various required positions.

Preferably the number of vanes is greater by one than the number of propeller blades so as to avoid sound interference between the blades and vanes. The vanes are preferably mounted between a central hub and an outer casing member so as to form a self-contained unit applicable to any type of engine in a stationary manner. Means are also provided for varying the position of the vanes simultaneously.

The invention will now be described by way of example to the accompanying drawings, wherein:—

Figure 1 is a partial sectional elevation on the line 1—1 of Figure 2,

Figure 2 is an end elevation of a screw propeller provided with a regulating device according to the invention,

Figures 3, 4, 5 and 6 show details,

Figure 7 is an end elevation of a screw impeller or pump,

Figure 8 is a section on the line 8—8 of Figure 7,

Figure 9 is a partial section on the line 9—9 of Figure 7,

Figures 10 and 11 show details.

Referring first to Figures 1 to 6 showing an example of construction as applied to an aircraft engine, the apparatus consists of a central streamlined boss 1 which is shaped to correspond with the adjacent aircraft or engine frame 2 to which it is to be attached. Arranged in spaced relation to the boss 1 is a circular outer casing member 3 of streamline shape which may extend over the propeller blades 4 with slight clearance 5. The outer casing member 3 is preferably of material sold under the Registered Trade Mark "Duralumin" and in cross section resembles a hollow aerofoil of which the outer side 6 is formed of sheeting.

In the hub 1 and casing 3 there are mounted uniformly spaced shafts 7 on which sleeves 8 are rotatably mounted. On each of these sleeves 8 is mounted at about its leading edge 10 a hollow vane 9 of aerofoil cross section. These vanes are of stainless steel of high elasticity or other strong material. Preferably each vane 9 consist of a number of sections arranged side by side along the length of the vane and slightly overlapping one another.

Intermediate the leading and trailing edges 10, 11 of each vane 9, preferably nearing to the trailing edge 11, a second shaft 12 passes through the vane 9 parallel to the first shaft 7.

Around the boss 1 there is mounted concentrically a casing member 13 which is secured positively to the boss 1. The shafts 7, 12 and sleeve 8 pass through this casing member 13 whilst the first shaft 7 is secured to the boss 1. To the lower end of the sleeve 8, inside the space between the casing member 13 and the boss 1, there is secured a lever 14 having a short slot 15 (Figure 4) for the reception of the lower end of the second shaft 12. Between the two shafts 7, 12, the lever 14 carries a guide pin 16, whilst a guide pin 17 is also secured to the lower end of the second shaft 12. A sleeve 18 is also mounted rotatably around the second shaft 12 and to the lower end of this sleeve there is secured a guide pin 19. The guide pins 16, 19, 17 engage with slots 20, 21, 22 in a governor plate 23 (Figure 3). The guide pin 16 on the lever 14 engages with the slot 20, the guide pin 17 on the second shaft 12 with the slot 22 and the guide pin 19 on the sleeve 18 engages with the slot 21.

The slots 20, 22 are parallel to one another and extend at about an angle of 45° across the central plane of the vane, the slot 22 being shorter than the slot 20.

The slot 21 is longer than the slot 20 and from its centre extends at both ends towards the slot 20.

By moving the governor plate 23 forwardly or rearwardly the curvature and the geometrical pitch of the vanes can be varied as may be desired so as to vary the "circulation."

The governor plate 23 can be moved manually, hydraulically, mechanically, pneumatically, electrically or in any other suitable manner.

As will be appreciated a separate governor plate 23 is provided for each vane 9, the separate plates 23 being coupled together in any suitable manner so as to operate in synchronism.

The plate 23 is preferably brought into

the neutral position for a cruising speed which determines the most suitable ratio of the geometrical pitch to the diameter of the propeller for the design of the latter.

For taking off there are used the negative angles of pivoting and for maximum speed the positive angles of pivoting.

When the governor plate 23 is in the neutral position the guide pins 16, 19, 17 are all in alignment with the central plane of the vane 9.

When all the slots 20, 21, 22 are parallel to another then on movement of the governor plate 23 the vane 9 has a constant angle of inclination. By constructing the central slot 21 as above described a variable angle of inclination is obtained, the angle being greater at the tip than at the hub end of the vane. Further by the engagement of the guide pin 17 with its slot 22 there is also effected a twisting of the vane into an aerofoil of different curvature.

Figures 5 and 6 show respectively in plan the outer and root ends of the vanes. The full line position corresponds with the neutral positions, whilst the chain dotted lines indicate regulating positions.

By making the hub 1 hollow the apparatus can be arranged in front of a hollow propeller hub 24 without interfering with firing through the propeller hub 24.

As the hub 1 is stationary the application of de-icing arrangements is facilitated.

Provision may also be made for circulating heated air through the shafts 7, 12, which are hollow, and shroud 13 for preventing the formation of ice.

Referring now to Figures 7 to 9 which show the invention applied to an impeller fan or pump the mechanism for varying the pitch and camber of the vanes is mounted inside a casing 25 connected by radial webs 26 to an outer housing 27. As the housing 27 is not spaced a considerable distance from the casing 25 a shaft 28, to which a vane 29 is secured near its leading edge, passes at one end through the casing 25 and a frame member 30, secured to the casing 25, whilst its other end is free.

Near its trailing edge the vane 29 is secured to a shaft 31 provided at its inner end with a ball 32 engaging with a corresponding seating in the casing 25. From the ball 32 there extends inwardly a spindle 33 which passes through an arcuate slot 34 in the frame member 30.

To the inner end of the shaft 28, inside the frame member 30 is secured a lever 35 which is provided with a slot 36 with which the inner end of the spindle 33 engages.

To the shaft 28 is also secured an arm 37, whilst an arm 38 is secured to the spindle 33. The arms 37, 38 are connected together by a link 39 which engages with the arms by ball joints.

The levers 35 for actuating the separate vanes 29 are each provided with a pin 40. These pins 40 engage with a floating ring 41 which can be actuated manually, hydraulically, mechanically, pneumatically, electrically or in any other suitable manner. By the rotation of the ring in one direction or the other the pitch and camber of the vanes 29, are varied whilst the vane is also twisted into an aerofoil of different curvature as hereinbefore described with reference to Figures 1 to 6.

The impeller is indicated at 42 whilst its driving motor is indicated at 43.

If desired a further set of vanes may be arranged behind the impeller 42.

Brackets 44 serve to support the motor casing 43.

As shown in Figure 10 a vane 45 is hollow whilst the portions of the shafts 46, 47 which pass therethrough are of oval or elliptical cross section.

In Figure 11 a vane 48 is formed of a single layer of material of which one end is looped around the oval or elliptical portion of a shaft 49. The second shaft 50 secured to the vane 48 is made as flat as possible.

It will be understood that the invention as above described is applicable to all types of propellers or impellers, or to pumps, turbines or other apparatus having blades or vanes and wherein a fluid is adapted to be attacked by blades or vanes or is adapted to act on blades or vanes for the rotation of a member to which the blades or vanes are connected.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. Apparatus applicable to screw propellers, impellers, pumps or the like, provided with a number of flexible vanes of variable pitch and variable camber pivotably mounted in a stationary position relatively to a screw propeller, so as to enable them to be set at a positive or negative angle.

2. Apparatus according to Claim 1, wherein the vanes are hollow and are constructed of stainless sheet steel of high elasticity or of other suitable flexible material, for example canvas.

3. Apparatus according to Claim 1 or 2, wherein the number of vanes is different from the number of propeller blades so as to avoid sound interference between the

blades and vanes.

4. Apparatus according to any one of the preceding claims wherein mechanism is provided for varying the pitch and the camber of all the vanes simultaneously.

5. Apparatus according to any one of Claims 1 to 3, wherein mechanism is provided for varying the geometrical pitch along the separate vanes.

6. Apparatus according to any one of the preceding claims, wherein two shafts extend through each vane, one shaft being located at or near the leading edge, whilst the other shaft is located towards the trailing edge, rocking movement of one shaft relatively to the other shaft serving to vary the camber of the vane at its trailing edge.

7. Apparatus according to Claim 4, wherein the mechanism includes means for twisting each of the separate vanes into an aerofoil of different curvature.

8. Apparatus according to any one of the preceding claims wherein the vanes are mounted between a central hub and an outer casing member so as to form a self-contained unit.

9. Apparatus according to any one of Claims 4 to 7, wherein the mechanism includes a slotted sliding plate, the slots in the plate being engaged by guide pins connected to two sleeves surrounding two shafts passing through each vane towards the leading and trailing edges thereof.

10. Apparatus according to any one of Claims 4 to 7, wherein the mechanism includes a lever secured to a shaft passing through the vane near the leading edge thereof, this lever being provided with a slot which is engaged by a spindle extending from a ball secured to the inner end of a shaft passing through the vane towards its trailing edge and seating in a casing surrounding the lever.

11. Apparatus according to any one of the preceding claims wherein the vane is constructed in sections arranged in close fitting overlapping relationship along the length of the vane.

12. Apparatus according to any one of the preceding claims, wherein the portions of two shaft passing through a vane are of oval or elliptical cross section.

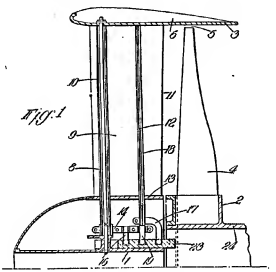
13. Apparatus according to any one of Claims 1 and 3 to 8, wherein the vanes are formed of sheet material, the leading edge being looped around an oval or elliptical shaft portion, whilst a second shaft secured to the vanes towards their trailing edge is made as flat as possible.

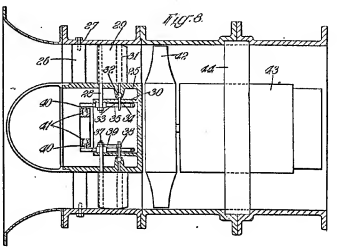
14. Apparatus applicable to screw propellers, impellers or the like, substantially as hereinbefore described with reference to the accompanying drawings.

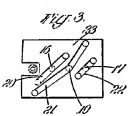
Dated this 4th day of March, 1942.

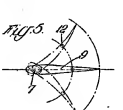
For the Applicants,
A. P. THURSTON & CO.,
329, High Holborn, London, W.C.1.
Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1942.









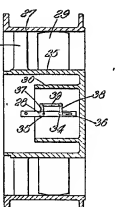


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Fig. 1.

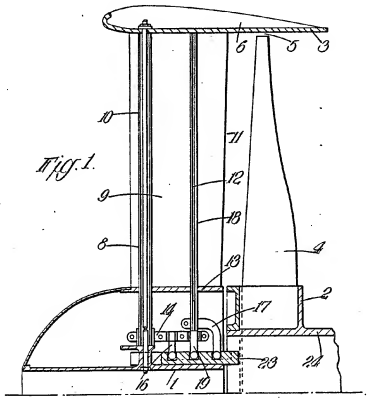


Fig. 3.

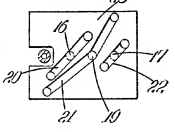


Fig. 5.

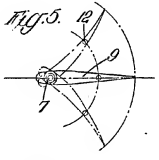


Fig. 4.

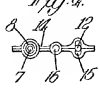


Fig. 6.

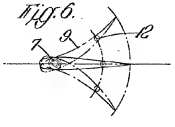


Fig. 8.

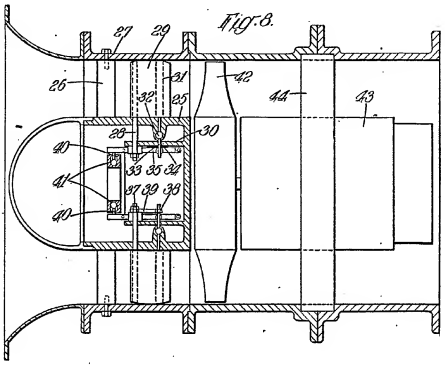
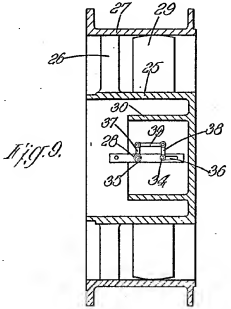


Fig. 9.



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545,587 COMPLETE SPECIFICATION

4 SHEETS
SHEET 2

SHEET 3

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Fig. 2.

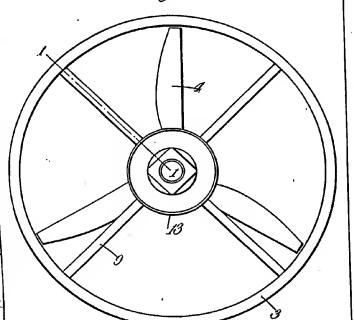

Fig. 7.

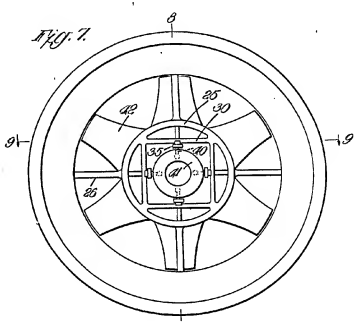

Fig. 10.

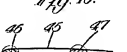

Fig. 11.

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Fig. 2.

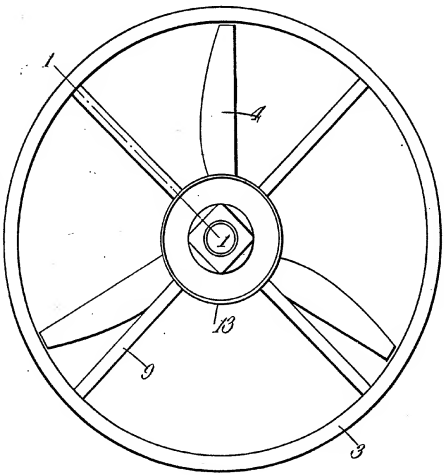


Fig. 7.

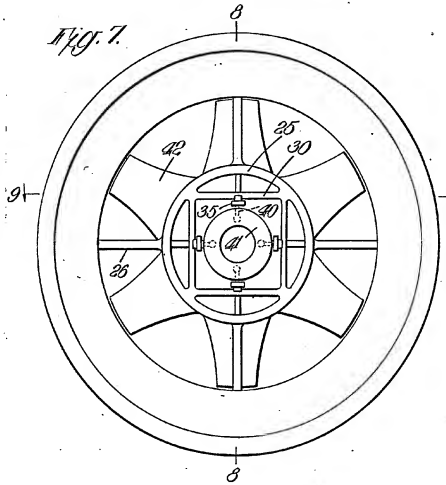


Fig. 10.

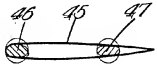
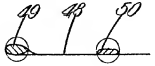


Fig. 11.



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